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A REPORT ON THE NIPAH PALM AND THE PRODUCTION OF ALCOHOL IN BRITISH NORTH BORNEO.

By J. H. Dennett.

IT is conservatively estimated that there is an area of at least 300,000 acres of Nipah Palm occurring in British North Borneo, available in blocks up to 5,000 acres. These areas extend up the river estuaries for distances of about nine or ten miles with a depth varying from a few chains to a mile.

In the naturally occurring state the palms grow so thickly that penetration is difficult and they flower but rarely.

The population of British North Borneo being small little exploitation has taken place for any purpose whatever. Initial conditions therefore differ greatly from those in the Federated Malay States, where, owing to exploitation either for attaps or for replacement by other crops, nipah generally, has been reduced to a fringe on the river banks. Nipah in this country thus resolves into an agricultural undertaking whereas in British North Borneo it remains a forest product.

Kuala Samawang.

The areas inspected were situated round the delta of the Samawang river about fifty miles to the northwest of Sandakan. It is here that the experimental plant for the production of motor spirit is situated. The delta above the mangrove region is covered with nipah for a distance of eight to nine miles. The depth varies from two chains to three quarters of a mile. The areas all appeared to be cut at intervals by creeks, from three to fifteen feet wide. This would facilitate collection.

It was found that these areas resembled the so called Nipah Gallah, *i.e.* The leaflets grow straight, almost vertically, a natural consequence of over-crowding, and but little fruiting occurs. Now that thinning has taken place the tendency is for the leaves to spread more *i.e.* to become so called Nipah Padi. Continual fruition is to be

expected as a sequence. The thinned area presents a much healthier appearance, is a better colour and bears much more fruit.

The fruit stalks although not all the same age could not be considered to represent all stages of development. Not one unopened bud was seen over the whole area, a very noticeable difference from this country where fruit may be seen at all stages of development throughout the year.

"Gonchanging" is said to be essential, the yield being thought to be proportional to the amount of preliminary treatment which the stalk receives.

Collection.

All the estimates made in British North Borneo either on the production of alcohol or sugar have been based on a working year of 180 days. It is believed however by thinning out that tapping may be continued for nine or even twelve months per annum, and that all palms will yield.

The area supplying the experimental factory was first tapped in January, 1924 and tapping was continued into June. As mentioned above the palms grow very thickly and it was found necessary after tapping has started to thin them out to about 300 per acre (c.f. M.A.J., Vol. XI, p. 59). In consequence the difficulties of collection were increased owing to the fruit being very scattered.

The juice is collected only once a day although a paring of the stalk is made every twelve hours. Collection is made in bamboo joints. These are emptied into kerosine tins in which the partially fermented liquid is conveyed to sampans. Bamboos are cleaned by smoking them over a fire.

It is considered that one coolie can tap sufficient palms to yield 80 gallons of juice per diem. Each palm is estimated to yield 10 gallons of juice in a season of 180 days. This amounts to over 4,000 lbs. of sugar per acre (c.f. M.A.J. estimate of 9,000 lbs. working a full year annually).

Sampans deliver the juice at the factory pier. Payment is made at the rate of 1 cent per gallon. Strength of juice is checked in factory to prevent dilution.

The Factory.

The experimental plant is capable of producing over 200 gallons (Imp.) of motor spirit per day, and was erected for a total cost of $42,000. The whole factory is housed in attap walls with corrugated iron roof. It may be divided into three parts:—

(1) the boiler house where a working steam pressure of 80 lbs. is maintained.

(2) the fermenting room and alcohol store.

(3) the still tower.

The fermenting room contains three fermenting vats of 1,600 gallons capacity each, and an alcohol storage tank of 4,000 gallons capacity. The juice is pumped from the sampans to these vats.

The still tower is conveniently divided into three stages or floors. The floors do not correspond with particular units of plant but are made to render the different parts accessible with convenience.

The alcohol fractionating still which is 18 to 20 feet high, and 18" in diameter and containing 25 fractionating plates, runs from the ground to the middle of the first stage, the upper half of this stage being occupied by the condensers. The ether still is almost completely situated on the ground floor, only the condensers being on the first story. The second floor contains the gravity constant pressure feed for the raw juice.

Distillation.

The fermented juice is allowed to stand in the fermenting vats for a period of about 24 hours, after which it is pumped to the feed vat on the second floor from whence it flows at constant pressure to the preheater on the ground floor, passing from that to the bottom of the alcohol fractionating still. Steam is also blown into the bottom of the still, vapourising the preheated fermented juice as it enters. The 25 plates cause a partial condensation of the vapours, the alcohol tending to continue up the tower and the water to run back to the bottom of the still. From the top of the still the uncondensed vapours pass into the dephlegmator or preliminary condenser where a further separation of alcohol and water tends to take place, owing to any water vapour still present condensing more readily than the alcohol, which tends to pass on to the condenser proper.

The condensed liquid, still containing a small amount of alcohol, passes back to the top of the tower by syphon, flowing down towards the base, to met by hot vapours passing up the tower. This liquid acts as a condenser to the water in the hot vapour while the latter vapourises the alcohol contained in the former.

In this manner a continual process of vapourisation and condensation takes place, alcohol vapour tending to pass on, water vapour tending to condense, until finally an almost complete separation of water and alcohol has been obtained, alcohol vapour passing through the dephlegmator, being liquified in the condenser proper, and water, free from alcohol, being run off at the bottom of the still.

The alcohol, unrectified and containing about four per cent. of water, flows to the alcohol storage tank on the ground floor.

Ether.

The ether plant is similar in principle and working to the one for the production of alcohol, but on a smaller scale. It has however a different unit in the lead-lined, steam-jacketed chamber where ether is formed by the re-action of concentrated sulphuric acid and alcohol.

Sulphuric acid extracts one molecule of water from two molecules of alcohol forming ether. This is well expressed in the following chemical equation :—

$$C_2H_5 \overset{\cdots\cdots}{\vdots} OH + H \overset{\cdots\cdots}{\vdots} OC_2H_5 = C_2H_5OC_2H_5 + H_2O$$

(alcohol + alcohol = ether + water)

The requisite amount of concentrated commercial sulphuric acid is run into the reaction chamber together with the proper proportion of alcohol for the start for the reaction. The vessel is maintained at a temperature of 140°. The ether volatilises as it is formed and passes to the bottom of the ether fractionating still. Here a similar process of vapourisation and condensation takes place to that occurring in the alcohol still. Before passing into the dephlegmator the ether vapour passes through the deacidifier which contains caustic soda. This removes any sulphurous acid (due to the partial decomposition of the sulphuric acid) which the ether may contain. The vapour passes on to the dephlegmator and condenser proper, condensed alcohol and water being returned to the still.

The process is continuous, alcohol being regularly drawn into the reaction vessel until the sulphuric acid is too dilute to react further.

The condensed ether flows from the condenser to the storage tank on the ground floor. The storage tank is itself fitted with a condenser owing to the volatile nature of ether. Water is continually pumped through this condenser, and from there to the two condensers situated on the first story.

Motor Fuel.

Thirty per cent. of ether and seventy per cent. of alcohol are generally mixed together with the addition of 1 per cent. of aniline, the latter partly as a denaturiser and partly to neutralise the acid exhaust gases which are obtained on combustion of alcohol and ether. This addition of aniline constitutes the Foster Patent. Fifteen per cent. of ether to eighty-five per cent. of alcohol has been used experimentally but no details of trials were available.

Trials.

The 1,000 gallons of motor spirit produced in the experimental plant during 1924 are being used in the P.W.D. lorries in Jesselton. It is claimed, with proper adjustment, an 80% efficiency is obtained compared with petrol. Engines are said to require less lubricating oil, to be free from over heating, boiling radiators, and to require decarbonising less frequently.

From figures which were available, the following estimates which appear to be conservative, are given.

Estimate A.

Present Experimental Plant.

Maximum Capacity 200 gallons of motor spirit per day (180 days per annum only).

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	3,300.00	6,600.00
Distilling costs ...	4,620.00	7,020.00
Other costs (Depreciation inclusive)	15,370.00	21,790.00
Gallons of Motor Spirit ...	18,000	36,000
All in cost per gallon ...	85.38 cents	60.50 cents

Estimate B.

Plant of maximum capacity of 2,000 gallons of motor spirit per day (180 days per annum only).

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	33,000	66,000
Distilling costs ...	19,185	31,170
Other costs (Depreciation inclusive)...	24,600	31,800
Total ...	76,785	128,970
Gallons of motor spirit ...	180,000	360,000
All-in cost per gallon in cents ...	42.65	38.82

Estimate C.

Plant of maximum capacity of 4,000 gallons of motor spirit per day (180 days per annum only.)

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	66,000	132,000
Distilling costs ...	30,210	61,920
Other costs (Depreciation inclusive)...	42,000	57,600
Total ...	138,210	251,520
Gallons of motor spirit ...	360,000	720,000
All-in cost per gallon in cents ...	38.38	34.93

Estimate D.

Plant of maximum capacity of 8,000 gallons of motor spirit per day (180 days per annum only).

Collecting costs	...	132,000	264,000
Distilling costs	...	60,960	103,320
Other costs (Depreciation inclusive)..		78,000	106,800
Total	...	270,960	474,120
Gallons of motor spirit	...	360,000	720,000
All-in cost per gallon in cents	...	37.63	32.92

It would appear from these figures that an economical undertaking would be the erection of a 4,000 gallon plant running 24 hours per day.

The percentage of the various heads of expenditure are summarised below.

	12 hours daily.	24 hours daily.
Collecting.		
Present 200 gallon plant.	21.48 per cent	30.35 per cent.
2,000 do	43.00 „ „	51.20 „ „
4,000 do	47.75 „ „	52.50 „ „
8,000 do	48.75 „ „	55.75 „ „
Distilling.		
Present 200 gallon plant.	30.10 per cent	32.20 per cent.
2,000 do	25.00 „ „	24.19 „ „
4,000 do	21.85 „ „	24.61 „ „
8,000 do	22.50 „ „	21.80 „ „
Other Charges.		
Present 200 gallon plant.	48.42 per cent	37.45 per cent.
2,000 do	32.00 „ „	24.61 „ „
4,000 do	30.40 „ „	22.89 „ „
8,000 do	28 „ „	23.45 „ „

The scheme for costs for working these larger plants is based on experience gained with the running of the present plant. It will be noted that the cost of collection is the heaviest head of charges for the larger scale operations, being always directly proportional to the quantity or motor spirit produced. In these larger scale estimates such costs as a head distiller, a visiting doctor, hospital, etc. are taken in account.

In the case of the 4,000 gallon plant running 24 hours per diem and the 8,000 plant, a superientendent at $600/- per mensem is included in the distilling charges. This accounts for the slight anomalies which will be noticed in the percentage costs under that heading.

Under the heading other costs it will be seen that the same depreciation is allowed, for the 24 hour operations as for 12 hour. Although this appears to be anomalous it must be remembered that it is estimated that the plant is running only 6 months per year. 10% depreciation may be considered quite high on such a plant, if running throughout the year. Thus it would appear rather that depreciation has been placed at too high a figure in the 12 hour, rather than too low a one in the 24 hour estimate, in order to be conservative.*

Competition.

Enquiries were made with regard to competition from petroleum interests. In British North Borneo an import duty is levied on petrol, but it is understood that in the Phillipines over two million gallons of alcohol are produced and used as motor fuel annually. This has led to no cutting in prices by the oil companies operating there, although alcohol motor spirit is cheaper than petrol even allowing for the fact that petrol is 25% more efficient (petrol itself is considerably cheaper in P. I. than locally). In this connection it was learnt that alcohol motor spirit is produced from molasses in the Phillipines at 29 cents (Straits) per imperial gallon.

Production in Borneo on a large scale at the present time would necessitate a sale in Singapore and Malaya generally. It is estimated that it could be sold wholesale in Singapore at a price appreciably lower than that of petrol. It would seem therefore that local producers would have a substantial advantage over competitors producing in

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*Estimates of all-in costs of plant for various sizes have been placed at the following outside figures.

Maximum capacity per day in gallons	Copper stills. All in cost. $
2,000	150,000
4,000	300,000
8,000	600,000

This figures are all very high, the larger plants costing less comparatively than the smaller ones. Redwood stills are considerably cheaper.

Mr. C. M. Hudson representing the Foster motor alcohol patents in the East gave the following approximate costs for a 2,000 gallon still manufacturing alcohol of 95% purity.

Copper	...	$35,000
Redwood	...	$20,000

F.O.B. Manila.

other countries, which would go towards realisation of interest on capital sunk in planting.

Conclusions.

From all the information obtainable in *British North Borneo* it appears that if areas, sufficiently large to keep the factory running are available, nipah can be efficiently and economically exploited for the production of alcohol and motor fuel at a price sufficiently low (after consideration of its 80% efficiency with proper carburettor adjustments) to compete successfully with petrol.

Thanks are due to Mr. D. D. Woods, Conservator of Forests, B.N.B., whose courtesy rendered this visit possible.

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A NOTE ON *LAELIA SUFFUSA*, WLK. (LYMANTRIIDAE) DAMAGING PADI.*

By

B. A. R. Gater and Mohammed Yusope.

Introduction.

During December 1924 about ten acres of padi situated at Sungei Star, near Parit Buntar, was attacked by leaf-eating caterpillars. Specimens were forwarded to the Entomological Laboratory asking for advice and stating that the plants were very stunted and weak as the result of the attack. Examination showed the presence of the Pyralid, *Cnaphalocrocis medinalis*, Guen. and some unknown Lymantriid larvae, the latter in considerable numbers. The larvae were bred out and the moths provisionally identified by the senior author as *Laelia suffusa*, which has not been recorded as a pest of padi as far as can be ascertained from the literature available.

Laelia suffusa has been mentioned by Joannis (4) as injurious to sugar cane in Java, while Duport (3) says it is a pest of this plant in the Far East. *Laelia* sp. is recorded on peanuts by Jarvis (6) *L. adara*, Moore, on sugar cane in Java by Joannis (4) and *L. devestita*, Wlk. is recorded as having been reared from larve on sugar cane and guinea grass at Pusa by Fletcher (7). *Laelia suffusa* has been described under the specific names of *angulifera*, Wlk., *prolata*, Swinh. and *subrufa*, Snell., while its distribution is given by Seitz (5) as India, Ceylon, Java, Celebes, Luxon, and Bago. It has thus not been recorded in the Malay Peninsula as far as can be seen from the available literature up to that date. It is unrepresented in the F.M.S. Museum.

Life History.

The moths copulate on the same day as emergence and the female begins to lay eggs on the following day. During the daytime the moths are quiescent, being active only in the evening and at night. The total life in captivity of the male was 3 to 9 days and of the female 5 to 12 days. Eggs are laid for a period of about 4 days, the greatest number laid by a single female in the laboratory being 176. An examination of the ovaries, however, revealed the presence of numerous undeveloped eggs, and the total possible number appears to be well over 260. The moths have not been observed feeding, and the haustellum is very short.

The eggs are laid in straight rows along the stem of the food plant, being cemented on by a transparent, slightly frothy, cement. Hatching takes place in from 6 to 7 days after oviposition, the larvae

* The identification is provisional, aud will be confirmed later. See the remarks under " Description of Stages, the Imago ".

emerging at the sides of the eggs and eating a portion of the shell as their first meal. They then rest, and do not begin to feed on the food plant for two days.

The larval life lasts from 25 to 37 days, the full grown caterpillars spinning their cocoons in a few hours and pupating on the following day. The duration of the pupal stage is from 8 to 13 days. In the laboratory there appears to be a preponderance of males, some egg masses producing no females at all. Out of 59 adults bred to date, 32 are males. There is some slight indication that the first batches of eggs produce males, females only coming from the later batches, and since it appears that the full number of eggs is not laid in captivity the preponderance of males would appear to be explained.

The following is a summary of the life history :—

Period.	Range.	Mean.
Emergence to oviposition -	1	1 day.
Incubation -	6— 7	6½ days.
Larval period -	25—37	30 „
Pupal period -	8—13	9½ „
	40—58	47 days.

Description of Stages.

The Egg.—The egg is roughly 0.75 m/m in diameter and 0.5 m/m high, and is of a light buff colour. The general shape is round, but two sides are flattened, these sides being in juxtaposition when the eggs are deposited in a row on the food plant. An examination of the eggs while still in the eggs-tubes shows that the flattening of the two sides is present before they are laid. On the two rounded sides there is a sub-marginal band of light green. The top is flattened, and depressed in the centre round the prominent micropyle. Chorion minutely tessellated. Just before hatching the colour changes to light grey.

The Larva.—On hatching the larva is 2 m/m in length and light greenish black in colour. The head is shiny black in colour and large, while the legs and prolegs appear to be disproportionately long. Long black hairs arise from small tubercles on the segments, those arising from two large tubercles on the first thoracic segment being the longest.

The full grown larva consists of 12 segments with the prolegs on abdominal segments 3 to 6. It is 20—35 m/m in length. Head dull ochreous with a black band round the mouthparts. Clypeus and antennae white, labrum bifurcate with a distal white margin; mandibles black. Five ocelli are present on each side of the head, a group of four within the black band and a single one below.

The general colour of the body is black, varying from velvet black on the dorsum to a lighter greenish black laterally and ventrally. Spiracles on the 1st thoracic and on abdominal segments 1 to 8 white with black edges. There is a longitudinal sub-dorsal stripe of canary yellow on each side, the colour deepening to orange yellow in the centre of each segment. Sublaterally there is a pink-white stripe which is white between and pink in the centre of each segment. Two subdorsal and two sublateral rows of papillae are present, from which arise groups of long, slightly plumose, brown hairs. Two long pencils of black hairs project forward from the first thoracic segment, the ends of these hairs appearing to be club-shaped owing to the lengthening of the plumes. Tufts of reddish brown hairs are present on the dorsum of abdominal segments 1 to 4, while a small tuft of similar colour is situated on the 8th abdominal segment From the centre of the latter there arises a pencil of black hairs similar to those on the 1st. thoracic. A glandular papilla is situated mid-dorsally on abdominal segments 6 and 7.

The writers have not had an opportunity of examining the original paper by Joannis (4) but the statement that this insect is inconspicuous when on its food plant, which appears in the extract given in the Review of Applied Entomology, appears to be somewhat peculiar in view of the very conspicuous colouration of the larva.

The Cocoon. The cocoon is ovoid, rather loose in structure, drab or light brown in colour and composed of silk and larval hairs. The male cocoon is 15 m/m long and 9 m/m broad, the female cocoon being 25 m/m long and 11 m/m in breadth. One end is rounded, while the other is pointed and left open for the emergence of the adult ; the hairs on this portion are derived from the pencils on the 1st. thoracic segment of the larva, and are arranged axially to the cocoon.

The Pupa. The pupa is light brown in colour, with darker brown at the junction of the segments, producing a slightly banded appearance. Length in the male 10 m/m and in the female 13 m/m ; general appearance stout. There is a slight dorsal ridge on the thorax, which is lightly clothed with hairs on its dorsal surface. There are 8 visible abdominal segments, segments 1 to 3 having a number of small tubercles placed dorsally in oval-shaped groups. Abdominal segments lightly clothed in long fine hairs. Spiracles slit-like and prominent, dark in colour. One or two small tubercles may be present subdorsally on each side of the anterior portion of the 4th abdominal segment, two being present especially in some males.

The Imago. The description given by Seitz (5) Hampson (2) and Moore (1) of this species varies to some extent, and some difficulty was found in fitting the specimens obtained to the description of the species given by these authors. Thus in Seitz the male is described as having *seven* spots on the forewing whereas in Moore it is described as having *six* only. It is not claimed that the species in question is definitely *suffusa*, Wlk. but as far as can be seen it is very near, although the differences between it and the description of *lilacina* Moore are small. The much darker hind wing of the male in the

Malayan insect points to it being nearer the latter species, but the spots are not arranged in quite the same way, the forewings are decidedly pink and there is no evidence of the violet tint mentioned in the description of *lilacina*. The description of the larva in Seitz appears to agree in general with the description given above. The name must remain uncertain until specimens from here have been compared with type specimens. The following rough description is given to show the differences from the description in Seitz :—

Male. Expanse 24 m/m. Head, palpi and legs ochreous ; long hairs from thorax light pink at base. Body white anteriorly, light fuscous posteriorly and light ochreous below. Forewings pale pink suffused with light ochreous scales in costal area. Six black submarginal spots, posteriorly incurved, the proximal spot being the largest ; hind-wings fuscous.

Female. Expanse 34 m/m. Head, palpi, collar and legs ochreous. Body white, suffused with ochreous below. Forewing very pale ochreous, almost white ; hindwings white.

The following description is taken from Seitz :—

" *Male.* Extremities ochreous, body and forewing white, with a faint reddish hue, the forewing with a submarginal row, posteriorly incurved as far as the middle of the dorsal area, of seven black spots. Hindwing pale, towards the margin hued darker."

" Female. Head, thorax and forewing uni-coloured, light ochreous, abdomen and hindwing white."

" Larva. Black, with long whitish hair, with tufts of long, spatulate, black hair on the sides of the 1st, and in the middle of the 11th segment, the 4th to 7th segments with four brown dorsal pencils, the 9th and 10th segments with round, whitish dorsal tubercles, one subdorsal and one sub-lateral yellow line, as well as yellow lateral streaks. Head and legs brown or black."

It should be noted that the figure given in plate 42 of Seitz shows the female as being smaller than the male, whereas in all the specimens reared in the laboratory the reverse is the case.

Economic Importance.

Apart from a few notable exceptions the Lymantriidae do not constitute pests of any great importance, and therefor attacks of great severity will probably not occur. In Malaya, however, so little is known of the common pests and so many unrecorded pests are continually being found, that caution is required in dealing with any unfamiliar insect. No parasites have been found on this insect, but collection of eggs and caterpillars in the field may eventually yield one or more. In the absence of parasites this insect may do considerable damage to padi, comparable to that done by other caterpillars which every now and then destroy several nurseries. Any specimens seen which resemble the foregoing description of the caterpillar should be forwarded to the Entomological Laboratory with notes of the area

attacked, locality, etc. so that more information can be obtained. At present little more than hand-picking can be done on Malay small-holdings, but the ordinary derris extract as made here would form an affective spray against the younger caterpillars. In the laboratory the larvae feed indiscriminately on padi, maize and several grasses. It is therefore possible that the wild grasses which surround padi fields will harbour the pest, and they should be cleared away as much as possible, especially during the time when there is no padi on the land and during planting out.

Literature Cited.

(1) 1882. Moore, F. Lepidoptera of Ceylon. Vol. 2 p. 83.

(2) 1892. Hampson, G. F. Fauna of British India, Moths Vol. 1 p. 441.

(3) 1913. Duport, L. Bull: Economique de l'Indochine, Nouvelle Série. No. 102. p. 313.

(4) 1913. Joannis, J. de. Bull: Soc: Entom; de France, No. 5. p. 137. (R. A. E. Vol; 1. p. 169.)

(5) 1914. Seitz. Macrolepidoptera of the World, English Edn. Vol: 10. p. 306.

(6) 1919. Jarvis, E. Queensland Agric: Jl. Vol: 12 No. 4. p. 200 (R. A. E. Vol; 8 p. 62.)

(7) 1921. Fletcher, T. Bainbrigge. Agric: Research Inst: Pusa, Bull: 100. p. 46.

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LATEX PAPER.

By B. J. Eaton.

SOME three or four years ago, considerable interest was aroused in the rubber and paper and pulp world as a result of investigations carried out by Kaye on the addition of latex to pulp for the manufacture of paper.

It was originally suggested by Kaye that the addition of latex to pulp in the manufacture of paper reduced considerably the time of beating required for the manufacture of the pulp and it was considered possible to prepare a cheaper and stronger paper by the addition to the pulp of latex equivalent to 1 to 3 per cent of rubber on the weight of pulp. Although no information as to cost is available at the moment, about a year ago, when our investigations were commenced, the price of latex paper was about 20 to 30 per cent higher than that of similar grades of non-latex paper

Except for (a) sentimental reasons, in respect of firms, estates and others who were interested in the consumption of more rubber and new uses for the commodity or (b) for special purposes in which a stronger or more durable type of paper was required, such as for documents which have to be stored or (c) unless the addition of latex cheapened the cost of manufacture, the use of latex in paper manufacture was not likely to be a success.

The application of latex to newsprint paper would only be successful, if the paper could be produced more cheaply, which does not appear to be the case up to the present. The use of latex paper therefore would be confined to paper required for special purposes, principally for documents which have to be stored. The most desirable property of such a paper is its keeping qualities or non-deterioration on storage. The results of several previous investigations carried out in the Bureau of Standards United States of America and by other workers indicate that any superior qualities conferred on paper by the additin of latex to the pulp are lost after the paper has been stored, and this is attributed to the resinification of the rubber. Owing to the fct that the amount of latex or rubber originally added to the paper tested was unknown, as also the original resin content, no investigations were carried out by us to determine whether the rubber originally added to the papers in the form of latex was resinified since such an investigation would have been of no value in the absence of such figures. It seems highly probable however that the rubber would be converted into resinous substances during prolonged storage or under accelerated ageing conditions.

In "The Rubber Age" (Volume V. No. 9 November, 1924, published in England, Kaye has replied to various criticisms of latex paper which were based on investigations on latex papers carried out

in America, and elsewhere. The figures given in his reply however do not appear convincingly favourable to latex paper when compared to similar results quoted for non-latex papers, especially in regard to durability tests.

The deterioration on storage appears to be not less in the case of the latex papers than in the case of the non-latex papers.

The folding tests in all cases shew appreciable deterioration in the case of both latex and non-latex papers with no advantage to

Page 78 para 4, add.

It would appear however that the original tests were carried out in the U.S.A. and the tests on the stored samples were carried out in England. The different conditions may account for the superior results shewn for the samples after storage.

The report contained [illegible]
out in The Chemical Division of the Department of Agriculture at the request of the Honourable the Chief Secretary to Government deals with various samples of paper received from the Government Printing Department and other samples obtained locally. Although it was not possible in every case to examine comparative samples, i. e. papers manufactured in a similar manner and containing similar constituents, apart from latex or rubber content, the results obtained, especially in the accelerated ageing tests, confirm those which have been published by other investigators and shew that, as far as these samples are concerned, the presence of latex in the paper does not appear to render the paper less susceptible to deterioration than papers which contain no latex.

Unfortunately, owing to lack of paper testing apparatus it was not possible to carry out complete physical tests on the samples.

In our opinion the application of latex to the manufacture of paper does not appear to hold any very definite promise of success in respect of its utility, either for ordinary purposes or in the case of papers for documents which have to be stored, unless the application of latex lowers the cost of manufacture. The application of latex to pulp in the manufacture of paper does appear to improve the surface for printing purposes, but it is probable that the demand for latex paper on account of this factor would be limited.

It seems probable however that the application of latex to the manufacture of latex boards for containers and other purposes, in which ordinary paper boards or cardboards are used, offers more promising possibilities. The vulcanisation of such mixtures of rubber (added in the form of latex) and pulp, after conversion into latex board will also probably increase the utility and applications of rubber for such purposes.

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A REPORT ON THE COMPRISON OF CERTAIN "LATEX" & "NON-LATEX" PAPERS.

By J. H. Dennett.

COMPARATIVE tests were carried out on a collection of samples of paper which had been selected by the Printing Department as likely to prove suitable for use for general purposes.

Description of Samples.

1. *Control.*—A Millbourne & Company's hand made paper. Cream laid and fairly smooth to the touch. Supplied by Printing Department.

2. *Kayes Latex Paper.*—A Millbourne & Company's hand made Kayelatex. Very slightly darker in colour, smooth to the touch but rather less so than control. Supplied by Printing Department.

3. *Stock Latex Paper.*—An almost dead white paper, very smooth to the touch, but considerably thinner than 1 and 2 above. No water marking. From appearance by transmitted light, probably machine made. Supplied by Printing Department.

4. *W. Howard & Sons Marked "A".*—A cream paper with colour rather unevenly distributed. Shows uneven texture when viewed by transmitted light. Rough to the touch. Supplied by Printing Department.

5. *W. Howard & Sons Marked "B".*— An almost dead white paper exactly similar in feel and texture to "A" above. Samples 4 and 5 said to be identical except that one contains latex. Supplied by Printing Department.*

6. *Java Latex Paper.*—Smooth finish but somewhat uneven in texture by transmitted light. Pale cream in colour. Obtained from a Dutch Paper Mill in Java.

7. *Java 100 per cent Straw.*—Made from the Straw refuse of the padi fields. Similar in texture to 6 above but rather lighter in colour. Obtained from a Dutch Paper Mill in Java.

8. *Latex Correspondence Pad.*—Bedford Bond water-mark. Ivory white in colour. Even in machine but a little rough to the touch. Obtained from Federal Rubber Stamp Company, Kuala Lumpur.

* It appeared from a chemical test that the sample of Howard's paper which contained latex was sample "B."

Testing.—The general testing of paper is a rather lengthy process involving chemical and physical tests. The latter for general purposes are of greater importance.

The most important physical properties to be examined are :—

(*a*) Folding properties

(*b*) Breaking strain and tensile strength

(*c*) Bursting strain

(*d*) Breaking length

(a) *Folding Properties.*—Owing to lack of the suitable apparatus it has been necessary to examine the folding properties by hand. The figures are given in table VI. The figures given for elongation at break (Table I) should to some extent be indicative of the folding properties.

(b) *Breaking strain and tensile strength.*—These are determined together. The former being the actual force required to break a given paper of some known width irrespective of its thickness, while tensile strength is a measure of the strength of any given paper taking into consideration the thickness of the sample.

(c) *Bursting Strain.*—No suitable apparatus was available for bursting tests.

The following tables give the results obtained for breaking strain and tensile strength of the above papers.

The figures may be taken as some indication of the tearability of the paper.

The samples were broken in Schopper's Rubber Testing Machine, which automatically records the force required to break any piece of paper clamped between the jaws.

Strips were made 2.54 centimetres (1") wide and were of sufficient length to allow of the initial distance between the jaws (after insertion of the strip) to be 10 centimetres.

The samples described gave the results recorded in Table I.

TABLE I.

Papers.	Across the Machine.						With the Machine.					
	Number of strips tested.	Mean thickness of strips in Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms.	Breaking force per sq. Millimetre Cross section (in grams)	Elongation at break per cent.	Number of strips tested.	Mean thickness of strips in Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms.	Breaking force per sq. Millimetre Cross section (in grams)	Elongation at break per cent.
1. Control ...	12	0.1398	122	10.74	3026	9.1	6	0.1360	114	12.50	3622	7.3
2. Kayes ...	12	0.1465	123	10.05	2701	7.0	12	0.1452	153	13.52	3668	7.0
3. Stock latex ...	14	0.1024	140	3.30	1267	4.4	14	0.0978	121	6.32	2545	2.8
4. Howards "A" ...	12	0.1880	128	7.01	1468	7.0	12	0.1877	113	11.08	2324	5.2
5. Howards "B" ...	12	0.1785	134	7.65	1687	8.0	12	0.1788	123	11.80	2598	6.2
6. Java latex ...	10	0.1019	120	5.21	2013	7.0	12	0.1022	142	10.99	4235	4.2
7. Java straw ..	10	0.1416	126	7.29	2025	10.5	10	0.1419	87	12.01	3280	5.2
8. Corr. pad latex ...	9	0.1200	94	5.25	1732	6.6	7	0.1202	135	10.25	3368	4.2

Note :—These figures although comparable amongst themselves are not directly comparable with similar figures obtained on papers tested in countries having a dissimilar atmospheric humidity.

It will be noticed that there is a marked difference between the tensile properties of the paper according to the direction of rupture. With a machine made paper there is a definite grain, which will exert an influence in resisting or yielding to a breaking strain according to the direction of application of the force. The action is comparable to the behaviour of the "chick" blind when loaded from the bottom in one case or when loaded in the other case from a direction at right angles to the normal hanging position. It will be evident that a much greater force will be required to break the chick in one direction than in the other.

For general purposes, to obtain average values for breaking force it is conventional to take the mean of the break with the machine, and, across the machine.

In the following table the papers are arranged in the order:—

A. Of their break across the machine

B. Of their break with the machine

C. Of their mean break.

TABLE II.

A Across machine	Breaking force in Kilograms.	B With machine.	Breaking force in Kilograms.	C Mean.	Mean breaking force in Kilograms.
Control	10.74	Kaye	13.52	Kaye	11.78
Kaye	10.05	Control	12.52	Control	11.62
Howards B	7.65	Java straw	12.50	Howards B	9.92
Java straw	7.29	Howards B	11.01	Java strew	9.65
Howards A	7.01	Howards A	11 80	Howards A	9.04
Corr: Pad latex	5.25	Java latex	10.08	Java latex	8.10
Java latex	5.21	Corr: Pad latex	10.99	Corr: Pad latex	7.75
Stock latex	3.30	Stock latex	6.32	Stock latex	4.81

If the papers are arranged in descending order corresponding to the figures obtained for their tensile strengths recorded "across the machine," "with the machine" and the mean of "across" and "with the machine" the samples examined appear as arranged in Table III.

TABLE III.

Cross	Tensile strength grms. per sq.millimetre.	Machine	Tensile strength grms. per sq.millimetre.	Mean	Tensile strength grms. per sq.millimetre.
Control	3026	Java latex	4235	Control	3324
Kaye	2701	Kaye	3668	Kaye	3185
Java straw	2025	Control	3622	Java latex	3124
Java latex	2013	Corr. Pad (latex)	3368	Java straw	2652
Corr. Pad Latex	1722	Java straw	3280	Corr. Pad (latex)	2545
Howards B Latex	1687	Howards B (latex)	2598	Howards B (latex)	2142
Howards A	1468	Stock latex	2545	Stock latex	1906
Stock latex	1267	Howards A	2324	Howards A	1896

The difference between Tables II and III will be appreciated when it is remembered that table II only gives a comparison of the papers irrespective of their thickness while table III gives a truer scientific comparison of the value of the papers, as in the results recorded the figures have been reduced to a basis of 1 sq. millimetres cross section.

(c) *Breaking length.*– This may be described as the length of paper, which if suspended from one end would break at the point of suspension by reason of its own weight. The convenience of this expression lies in the fact that it is entirely independent of the width of the strip.

From the breaking forces obtained in Table I the following breaking lengths have been calculated. They are arranged in descending order of magnitude.

TABLE IV.

Paper.	Mean weight per sq. metre in grms.	Mean breaking length in metres.
Kaye ...	106.9	434
Control ...	107 0	428
Corr. Pad latex ...	79.1	387
Java Latex ...	83.75	382
Java Straw ...	110 5	344
Howards B ...	131.9	297
Howards A ...	131.0	272
Stock latex ...	81.6	232

Table V gives the proportion of mineral-matter per cent found in the papers. The results are arranged in order of magnitude.

TABLE V.

Paper.	Per cent Mineral Matter.
Control ...	1.0
Kaye ...	1.7
Java latex ...	5.2
Howards B (latex) ...	5 5
Howards A ...	6.0
Java straw ...	11.0
Stock latex ...	14.0

The figures are to a large extent indicative of the loading matter in the papers and to some extent account for the difference in the properties.

OBSERVATIONS.

From the various tables set out above it would appear that Kayes Latex Paper has about the same general value as a similar paper (control) without latex. The mean breaking force is slightly higher than that of the control, as is also the breaking length. On the other hand the mean tensile strength is slightly lower than the control. Java Latex Paper is better than the similar all-straw paper.

Howards B (latex) is superior throughout to Howards A.

The stock latex paper is very poor compared with all the others, due largely no doubt to its much heavier "loading" as shewn by the ash.

Ageing Tests.

In the further tests described below, another sample of latex paper has been tested in place of (8) and in this report is designated as "Kalatex." This is a machine made paper, very smooth to the touch and rather thinner than (2).

The conditions under which the samples were aged were as follows:—

(a) Samples wrapped in brown paper and stored in a cupboard for 5 months.

(b) Samples stored in glass stoppered bottles, freely exposed to diffused light at room temperature (about 28°C) for five months.

(c) Samples stored in glass stoppered bottles in an oven, heated by boiling water. Heating continued for 6 hours daily for five months.

(d) Samples stored in glass stoppered bottles and exposed to direct sunlight for 8 hours daily for 5 months.

The samples were under the influence of atmospheric moisture throughout.

The following observations are offered under the headings (b) c) and (d).

(b) In this case a general yellowing effect was observed, more noticeable in some samples than in others.

The order of their resistance to yellowing is as follows;—

Control.

Kayes.

W. Howards "B"

Kalatex.

100% Straw.

Stock Latex.

W. Howards sample "A" (yellowish at commencement)

Java Latex.

(c) No change was observed generally in the samples kept in the laboratory except samples 2., 4. and 8 which shewed a very slight bleaching compared with the samples stored under conditions (a)

(d) A general bleaching effect was observed, this was particularly noticeable with regard te sample (4).

Folding Properties.

The folding properties were determined by two methods; (i) by machine after storage under conditions (b) above (ii) by hand before storage.

(i) *By-machine.* No proper folding machine was available. The method adopted was as follows. Six pieces of paper 6" square were cut from each of the samples under examination. Three pieces of each batch of six were carefully folded along the length, down the centre of the paper. The other three were folded in a similar manner along the breadth. The papers were then passed through the upper rolls of a rubber calendering machine. As they came out the papers were folded back along the same line and again passed through the rolls. The process was repeated until the paper was broken completely into two halves along the line of fold. It will be realised that by this means the papers were broken much quicker than by hand.

(ii) *By hand.*—This method has but little scientific value as the personal error is very great.

The following table shows the results. The figures are the mean of three pieces, across, and with the machine.

Table VI.

Paper.	By rollers (after ageing under) conditions (b)	By hand (Before ageing.)
Kayes Latex ...	44	257
Control ...	33	246
Kalatex ...	28	*
Howards "B" ...	16	243
Stock Latex ...	16	60
Java Latex ...	14	167
Howards "A" ...	10	235
Java Straw ...	8	121

While results by these two methods are only in very general agreement it will be seen that latex paper appears to be superior in this respect to the corresponding ordinary paper, Kayes Latex and Control (2) Howards "B" and Howards "A" (3) Java latex and Java Straw. For stock latex and Kalatax, there are no comparable non-latex papers.

Breaking Strain and Tensile Strength.

The samples, stored as described under (a) (b) (c) & (d), were all tested for breaking strain and tensile strength.

The breaking strain and tensile strength are given in Table VII.

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* This paper was received too late to be tested with the others. Results obtained by two persons being incomparable.

TABLE VII.

Paper.		Across the Machine.					With the Machine.				
		Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.	Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.
Control	a	0.147	41	12.60	3370	3.6	0.141	47	12 60	3515	3.7
,,	b	0.138	43	11.93	3400	3.6	0.138	50	14.77	4210	3.6
,,	c	0.135	47	10.57	3079	3.7	0.140	50	12.72	3633	3.5
,,	d	0.148	43	7.57	2015	3.1	0.151	53	9.52	2480	3.5
Kayes	a	0.146	64	11.97	3228	2.5	0.150	68	13.24	3479	3.9
,,	b	0.142	164	10.26	3009	3.3	0.138	98	14.65	4185	3.6
,,	c	0.146	86	10.54	2850	3.5	0.143	100	10.77	2967	3.5
,,	d	0.141	95	6.48	1808	3.4	0.142	88	8.08	2240	3.7
Stock Latex	a	0.095	56	3.40	1406	2.9	0.095	53	5.52	2287	2.2
,,	b	0.093	59	2.05	868	2.6	0.093	60	6 40	2709	2.2
,,	c	0.091	60	1.95	845	2.2	0.092	55	2.35	1070	2.2
,,	d	0.095	61	3.17	1311	3.4	0.095	59	4.32	1793	2.1
Howards "A"	a	0.170	60	8.15	1890	3.7	0.176	58	13.65	3053	3.6
,,	b	0.171	48	8.12	1870	3.4	0.171	56	12.32	2835	3.1
,,	c	0.167	60	7.20	1697	3.0	0.170	56	10.42	2412	3.1
,,	d	0.169	54	6.97	1624	2.9	0.171	54	10.05	2315	3.4

a = in dark, b = in laboratory, c = in oven, d = in sun.

TABLE VII—(*contd*).

Paper.		Across the Machine.					With the Machine.				
		Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.	Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.
Howards "B"	a	0.154	58	6.87	1760	4.0	0.158	60	11.27	2808	3.3
,,	b	0.160	48	7.40	1822	4.1	0.158	66	10.62	2650	3.5
,,	c	0.156	56	6.17	1556	3.1	0.156	60	7.72	1949	2.9
,,	d	0.160	54	5.60	1379	2.9	0 156	54	5.60	1413	2.9
Java Latex	a	0.090	53	5.07	2220	3.2	0.090	47	7.65	3346	2.6
,,	b	0.090	53	4.47	1955	3.0	0.090	58	8.60	3805	2.7
,,	c	0.085	62	2.77	1281	2.6	0.087	54	3.87	1751	2.7
,,	d	0.090	61	2.62	1147	3.1	0.092	54	3.20	1249	2.6
100% Straw	a	0.134	65	5.80	1704	4 5	0.135	50	12.62	3680	3.9
,,	b	0.132	54	6.55	1923	4.4	0.132	53	11.52	3436	3.4
,,	c	0.130	46	4.62	1396	3.4	0.131	58	8.52	2567	3.2
,,	d	0.132	54	6.37	1896	4.2	0.132	51	9.07	2674	4.0
Kalatex	a	0.099	51	4.14	1649	3.6	0.100	56	6.97	2744	2.9
,,	b	0.100	60	4.60	1811	3.4	0.100	64	7 1	2795	2.6
,,	c	0.100	47	3.25	1283	2.9	0.100	57	5.92	2330	2.5
,,	d	0.100	59	3.37	1366	3.4	0.100	53	5.62	2212	3.1

a = in dark, b = in laboratory, c = in oven, d = in sun.

In these tests the strips were again cut to a with of 2.54 cms. but in this instance the conditions of ageing rendered it necessary to make the initial distance between the jaws of the testing machine 7 centimeters.

It will be noted (Table VII) that there is again a large difference between the break with the machine and the break across the machine.

This table shews the great changes which have taken place in the paper on exposure to excessive light and heat.

For the most part the greatest deterioration appears to have taken place on exposure to the sun, exposure to heat only, having a rather less marked effect.

In Table VIII the papers are arranged in the order of their mean breaking strains across and with the machine, while in column 3, 4 and 5 will be found the percentage decrease in mean breaking strain on exposure to laboratory, oven and to the sun respectively.

TABLE VIII.

Paper	Mean breaking force under condition (a) Kilograms.	Mean per cent deterioration of breaking strain under condition. (b)	(c)	(d)
Control	12.60	− 5.95	*f* 6.82	*f* 32.27
Kayes	12.60	*f* 1.19	*f* 15.48	*f* 42.20
Howards " A"	10.90	*f* 6.25	*f* 19.18	*f* 26.50
Java Straw	8.21	*f* 1.95	*f* 28.65	*f* 16.17
Howards " B"	9.07	*f* 0.66	*f* 23.40	*f* 38.20
Jawa Latex	6.36	− 2.67	*f* 48.00	*f* 55.60
Kalatex	5.56	− 4.31	*f* 17.61	*f* 19.45
Stock Latex	4.46	*f* 5.38	*f* 51.75	*f* 16.03

− Represents an increase as compared with condition (a)

f Represents a decrease as compared with conditions (a)

It appears throughout table VIII that latex paper does not withstand the action of heat and light so well as the non-latex paper varieties. These figures apply only to the particular papers tested and not to the type of pulp from which they are manufactured.

Table IX corresponds to table VIII with the substitution of the tensile strength of the paper in place of breaking force, and the percentage deterioration of the tensile strength on exposure to laboratory heat and to the sun, in place of percentage deterioration of the breaking force. The essential of the table of tensile strength is that the figures apply to any sheet of paper made from the same pulp irrespective of its thickness.

TABLE IX.

Paper	Mean Tensile Strength in grm per sq. m.m.	Mean percentage Deterioration of Tensile strength under condition. (b)	(c)	(d)
Control	3442	− 16.75	*f* 2.50	*f* 33.00
Kayes	3353	− 7.28	*f* 13.33	*f* 39.65
Java Latex	2783	− 0.46	*f* 49.10	*f* 57.30
100% Straw	2692	*f* 2.40	*f* 26.43	*f* 16.85
Howards "A"	2471	*f* 3.20	*f* 16.88	*f* 20.35
Howards "B"	2284	*f* 2.10	*f* 23.31	*f* 40.60
Kalatex	2196	*f* 4.88	*f* 17.77	*f* 18.55
Stock Latex	1846	*f* 3.14	*f* 48.15	*f* 16 04

− Represents an increase as compared with condition (a)

f Represents a decrease as compared with condition (a)

OBSERVATIONS.

The results of tests carried out on the stored samples of paper indicate that of the two comparable papers Control (1) and Kayes (2) the latter containing latex deteriorates more under conditions storage (b) (c) and (d); the two papers Java Latex (6) and Java Straw (7) the latex paper deteriorates less under the laboratory conditions (b) but considerably more under conditions (c) and (d). In the case of the two papers Howards "A" without latex (4) and Howards "B" with latex (5) the figures show that the latex paper deteriorates less in the laboratory but more in the oven and in direct sun-light.

No observations can be recorded on the results obtained from comparable chemical tests carried out on the papers after storage under the different conditions specified. It was hoped to be able to record the results of an examination for resinification on the stored latex paper ; the chemical tests however did not yield results of any value, and it was decided to confine the observations to physical tests. It may however be recorded in passing that writing in various coloured inks on the different papers was equally affected for all samples during ageing.*

In studying the figures recorded for breaking strain and elongation at break after deterioration and comparing these figures with those recorded in the preliminary report due regard must be paid to the variations in atmospheric humidity during the two periods of

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* see Latex paper by B. J. Eaton. p.p.

testing, and that the length of the test strip in the aged samples was 3.0 cms shorter than that in the fresh samples.

Conclusions :—From the results of the above tests it appears that there is little to choose for general purposes, between a paper made from any particular pulp with and without latex. The latex paper certainly exhibits superior tensile properties when fresh.

After storage, the latex paper, although it retains its superiority to folding, exhibits a greater deterioration generally and this deterioration is enhanced by strong heat and direct sun-light.

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